Detector Cooperation with CLIC

PAC Pohang meeting

November 3, 2009

Outline

- Introduction
- ILD/SiD for CLIC ?
- Crucial R&D needed
- Political aspects (WG)
- Potential risks
- Conclusions

Introduction

- Following the initiative taken by Jean-Pierre Delahaye and Barry Barish, the ILC detector community has increasing technical collaborations with CLIC
- CERN has joined ILD and SiD and the major R&D collaborations and interacts directly with these organizations
- At CERN the DG has launched a 'LC project' beyond the usual technology frontier
- There are 10-12 FTE at CERN
- Will be X2 end of 2010

Questions

- Can ILC validated detectors ILD and SiD be used for CLIC at 3 TeV ?
- If not can one define common efforts within the R&D collaborations ? (e.g. calorimetry, µvertex RO, new SC for the coil, push-pull issues, engineering…)
- There is of course a caveat given the different roadmaps: CLIC only foresees a TDR in 2016 but needs to provide a CDR in 2010
- ILC, with limited resources (e.g. in the US), needs to complete a detailed baseline study end of 2012 in conjunction with the ILC TDR
- Any initiative should be considered within the ILC roadmap constraints avoiding diversion in our priorities

Similar detectors ?

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	25.2 %	3.7 %
100 GeV	28.7 %	2.9 %
180 GeV	37.5 %	2.8 %
250 GeV	44.7 %	2.8 %
375 GeV	71.7 %	3.2 %
500 GeV	78.0 %	3.5 %

- From studies already reported at PAC (M. Thomson from ILD) PFLOW appears relevant for a multiTeV collider provided that the HCAL is increased to ~8Λ_I
  - ➡ CLIC is studying a **W HCAL**, more compact
- Potential benefit for ILC detectors which could reduce the size of the SC coil but costly solution (100€/kg)
- The CALICE collaboration has taken seriously this possibility
- Recall that the PFLOW simulation assumes >99% efficiency on tracking achievable in the ILC environment
- Can this figure be maintained at CLIC at 3 TeV with larger, more energetic $\gamma\gamma$ background and challenging duty cycle (BX every 0.5 ns) ?

Challenges with tracking

- Recall that while SiD assumes perfect time separation (time stamping) of the data recorded at different BX which seems feasible (but challenging) with ~300 ns BX separation, ILD assumes 50 μs integration for the μvertex
- For the TPC of ILC $\gamma\gamma$ events recorded at different BX give well separated vertices which allows topological separation
- CLIC has a 300 BX with 0.5 ns separation

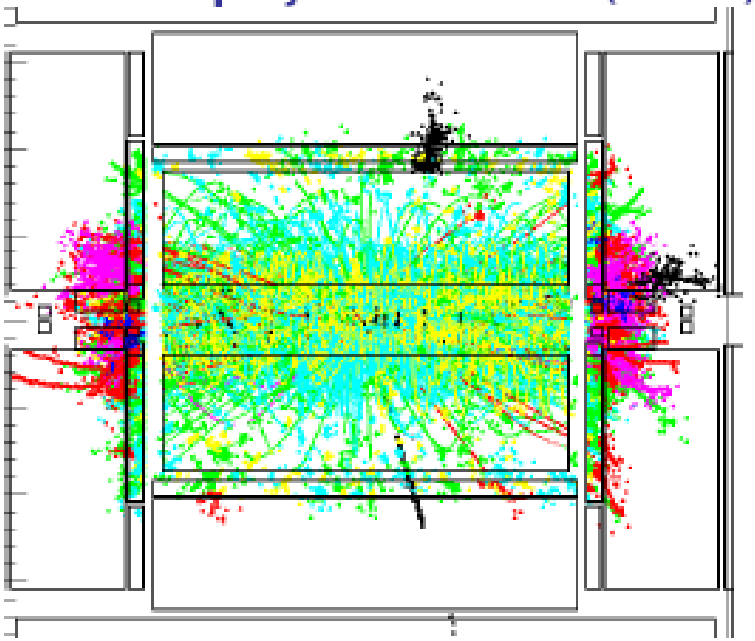
Consequences

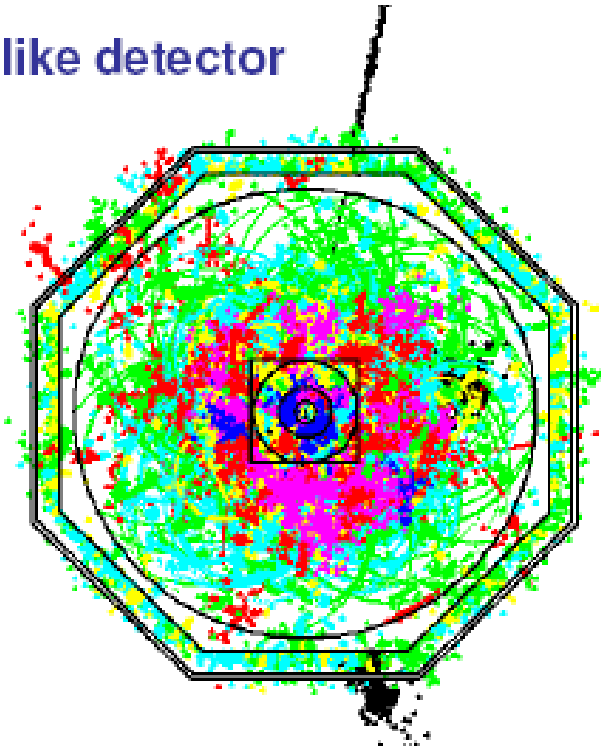
- First simulations were reported by M. Thomson at **CLIC09**
- There are indications of significant loss in performances (HA study) in the absence of stamping
- Criticality of the FWD region (e.g. H physics from fusion)
- Need an 'aggressive' R&D to perform time stamping on tracking (see 3DIC for vertically integrated Si pixel detectors) and forward calorimetry
- Could be of use for ILD-SiD in particular for what concerns the μvertex

Two-photon → hadrons background

- ★ Preliminary studies (Battaglia,Blaising,Quevillon) indicate significant two photon background for 3 TeV CLIC operation
- ★ Approx 40 particles per BX $(p_T > 0.15\,\mathrm{GeV}\ ,\ |\cos\theta| < 0.98)$
  - ⇨ ~40 GeV visible energy per event

e.g. Event display for 150 BXs (75 ns) in ILD-like detector





- ★ Results need checking (preliminary)
- ★ With 0.5 ns BX – will inevitably integrate over multiple BXs, how many?
- ★ CLIC at 3 TeV may look rather different to the ILC environment
- ★ In addition, there is also the pair background…

Political aspects I

- CLIC needs help from ILC experts to produce a CDR and calls editors from our community
- CLIC wishes to merge its workshops with ILC (note that there is a large overlap between participants at ALCPG09 Albuquerque and CLIC09 at CERN)
- CLIC wishes to intensify work on R&D through the existing collaborations
- ILCSC has encouraged formation of a CLIC/ILC General Issues working group on detectors
- The format of this WG is under discussion with the CLIC partners

Joint Working Group on General Detector Issues

- November 2, 2009 approved version
- ILCSC has encouraged formation of a CLIC/ILC General Issues working group on detectors by the two parties with the following mandate:
  - **Promoting the physics and the detectors of the Linear Collider**
  - **Identifying synergies between the detectors of ILC and CLIC in performance studies, detector R&D, and software tools**
  - **Discussing detailed plans for the ILC and CLIC efforts, in order to explore possible collaborations on issues such as critical R&D on sub-detectors, coil studies, push-pull mechanism and MDI aspects**
  - **Discussing a possible format of collaboration between the ILC validated detector groups and CLIC**
- The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board.

Political aspects II

- The actual content of these various CLIC-ILC collaborations to be decided directly by the interested parties (mostly CERN and the ILC groups)
- For what concerns the participation of members of SiD and ILD to the CLIC CDR we feel that it should be done in agreement with these collaborations
- For what concerns the workshops we are already organizing the next European WS (**ECFA WS at CERN** in Sept 2010) with an OC comprising CLIC+ILC representatives
- These various initiatives should further improve the good relationships between the two communities

Potential risks

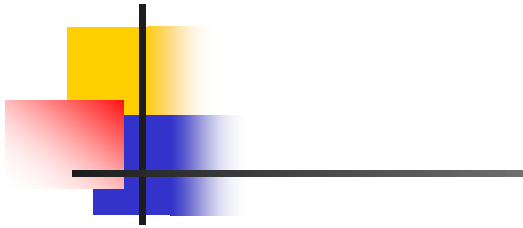
- ILC is an international organization under ICFA/ILCSC with a well defined roadmap
- While CLIC-ILC collaboration appears very natural in Europe we need to make sure that it is agreed upon in the two other regions
- CLIC needs an international R&D oriented towards a multiTeV collider not necessarily overlapping with ILC priorities

Which Scenario ?

- The scenario proposed by the CERN DG at LCWS08 in Chicago is that LHC should provide the scientific input for a final choice (through a process which needs to be carefully defined) recalling that ILC is ~ready for construction while CLIC at 3 TeV remote in time
- CLIC500 however appears in direct competition with ILC and the community would like to see clear rules of the game for the assessment of this technology (new ITRP ?)
- While we fully appreciate the usefulness of the ongoing process to avoid damaging competition the community needs to be well informed on the overall scenario

Conclusions

- CLIC/CERN can bring tremendous help in improving the ILC detectors
- One should therefore encourage the ongoing collaborations but insuring mutual benefits and avoiding distraction of efforts on the main goal
- The proposed CLIC-ILC WG on detectors should allow better communication
- Common CLIC-ILC workshops will be tried at the next ECFA workshop at CERN
- There are clear specific needs for CLIC which may require marked differences between the detectors and the R&D needs but one can foresee important overlaps
- Political risks cannot be minimized and one needs ICFA/ILCSC/PAC guidance



BACK UP SLIDES

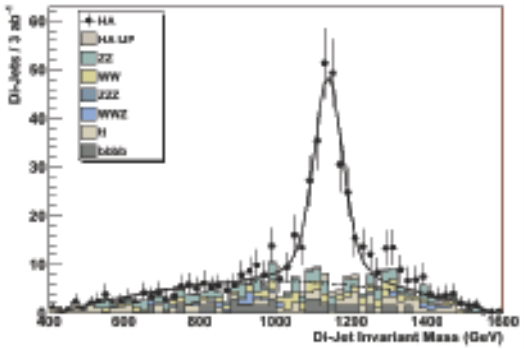
Time stamping requirements (2)

Simulation example of heavy Higgs doublet H^0A^0 at ~1.1 TeV mass (supersymmetry K' point)

e+e- → H^0A^0 → bbbb

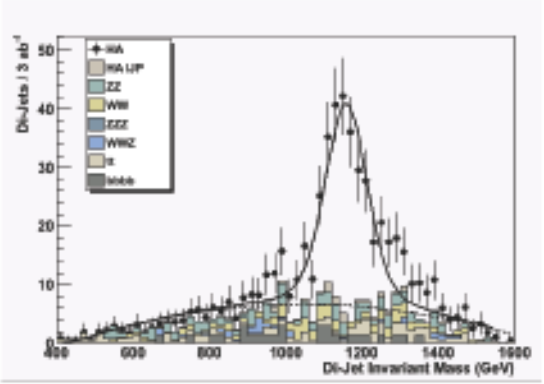
Signal + full standard model background + γγ=>hadron background

CLIC-ILD detector: Mokka+Marlin simulation, reconstruction + kinematic fit.



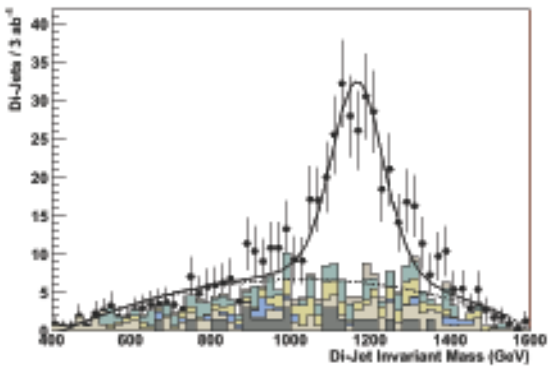
Zero bunch crossings

M_A mass resol. 3.8 GeV



20 bunch crossings

M_A mass resol. 5.6 GeV



40 bunch crossings

M_A mass resol. 8.2 GeV